

Nested Grid Climate Simulations In The GFDL High-Resolution Atmosphere Model

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LOCAL REFINEMENT OF A GLOBAL MODEL GRID

- Want to improve representation of regional details, especially those which affect larger spatial scales
- Stretched-grid models' varying resolution restricts timestep and parameterizations
- Two-way nesting more versatile and allows separate parameterizations, but requires attention to boundary conditions and the regional-to-global update
- Two way nesting is very uncommon in global models

GFDL HIRAM: **HIGH RESOLUTION ATMOSPHERE MODEL**

- Model developed for efficient high-resolution (c180/0.5° and better) climate simulation
- Finite-volume hydrostatic dynamical core on the cubed-sphere grid
- Two-moment UW shallow+deep convection scheme and “six-phase” Lin (1983) microphysics

TWO-WAY NESTING

- Boundary conditions linearly interpolated from coarse grid
- Two-way update: coarse-grid periodically replaced by nested-grid solution. Only winds and temperature are updated.
- Air mass and tracer mass not updated to coarse grid and so trivially conserved

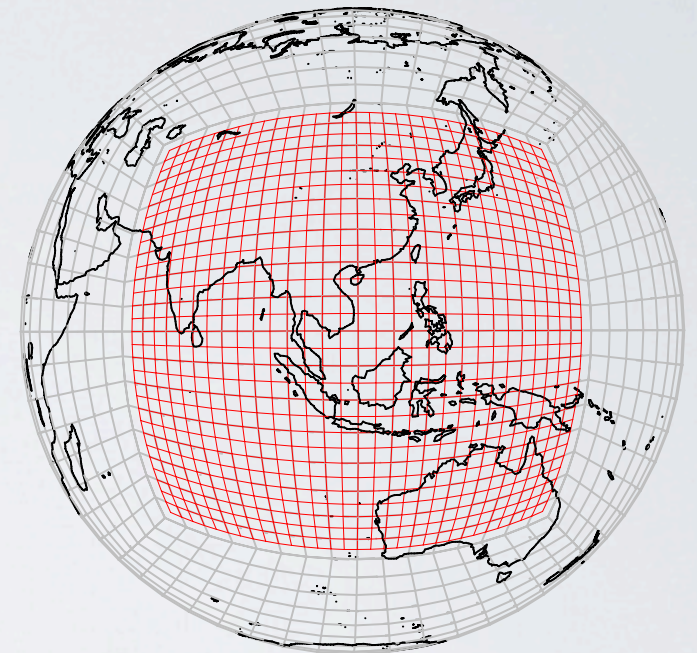
FROM SINGLE GRID TO NESTED GRID SIMULATIONS

- Start by tuning a single-grid simulation to get as good of a global climate and regional details as can reasonably be expected.
- Keeping the global grid tunings constant, then tune the nested grid to improve regional details.
- **How much can we improve regional details on the nested region?**

SIMULATIONS

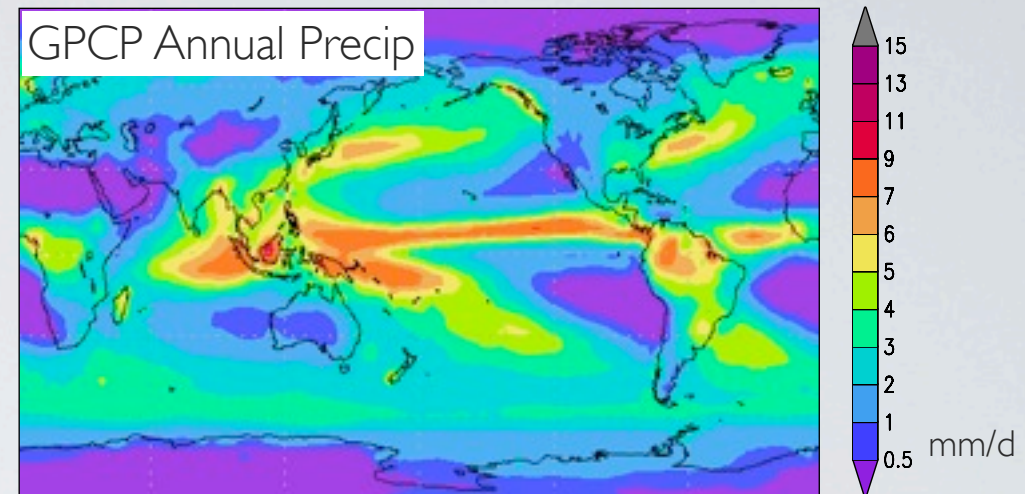
- Two controls: single-grid c90 (1°) and c192 (0.5°) 30-year AMIP simulations.
- Nested simulations: factor-of-three for c90, factor-of-two for c192
 - 30-year AMIP complete for c90 NA nest; others are *preliminary* 5-year climatological SST simulations
- Next project: nest to <10 km grid spacing

Maritime Continent Nest (MC)

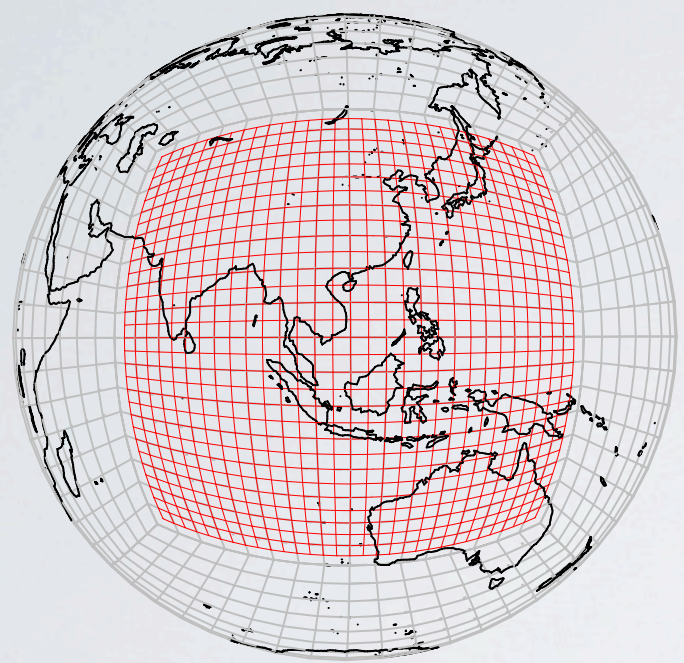


North America Nest (NA)

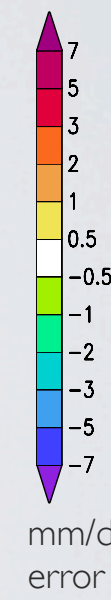
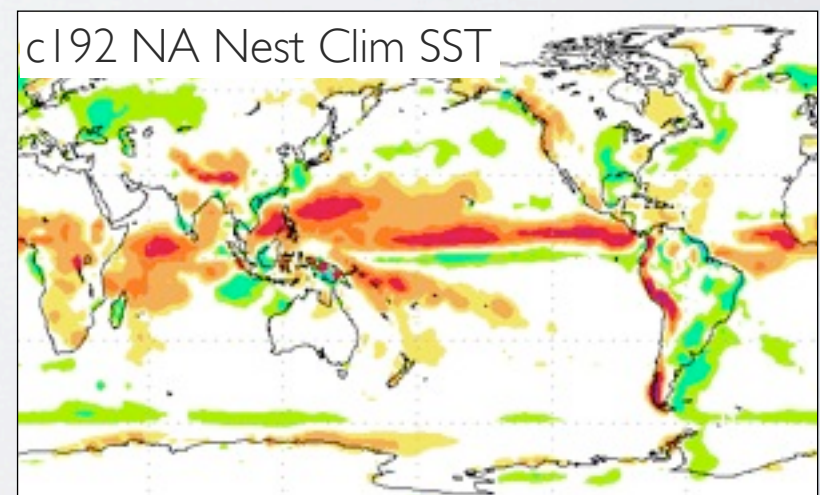
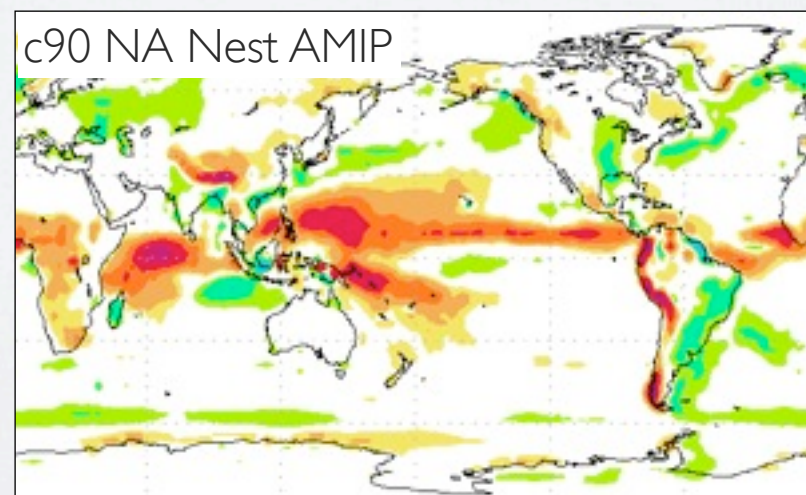
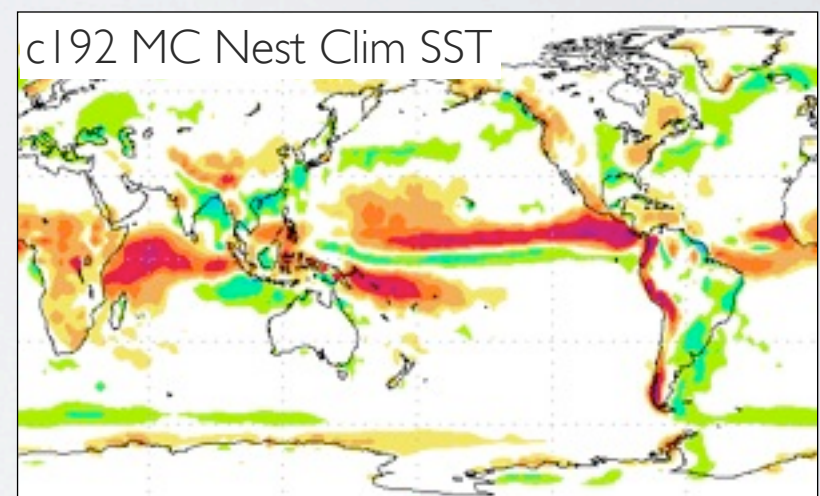
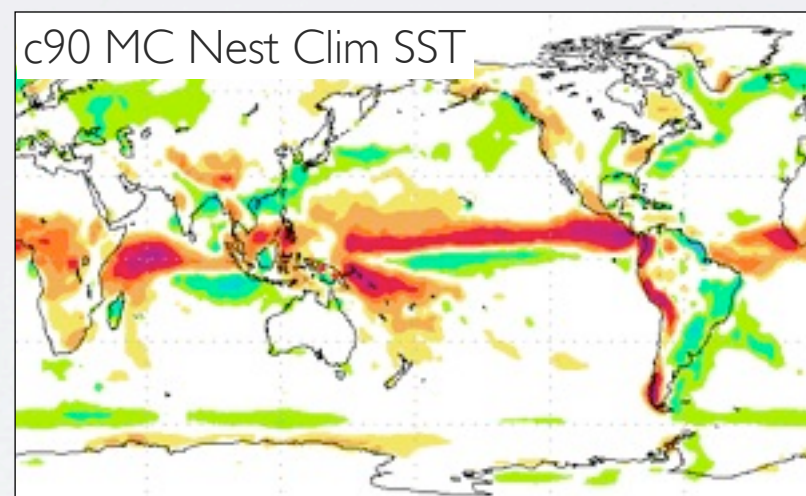
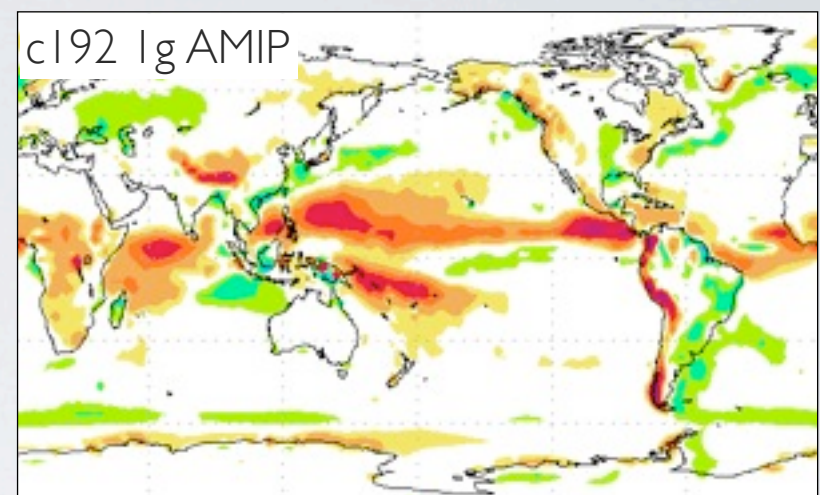
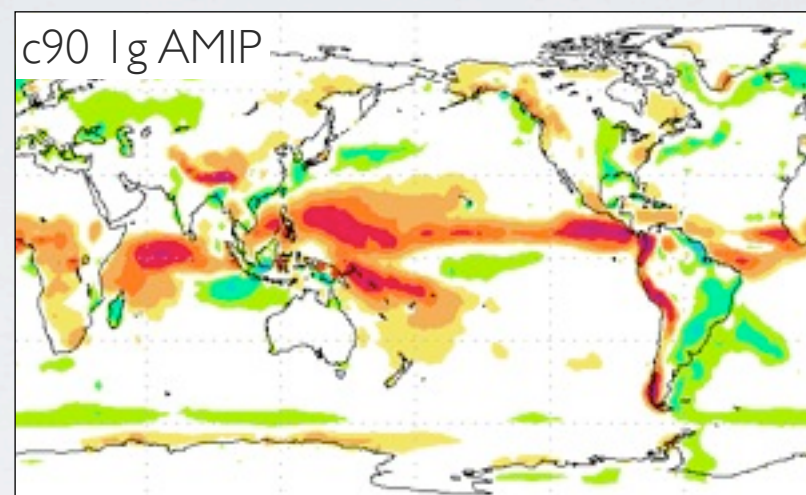
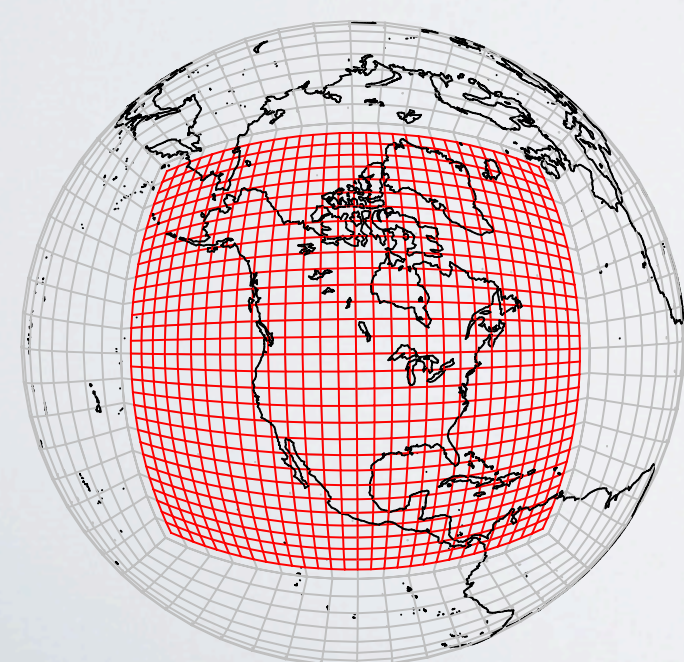




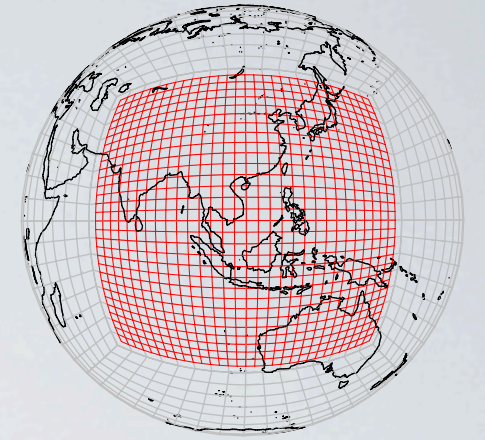
Maritime Continent Nest (MC)



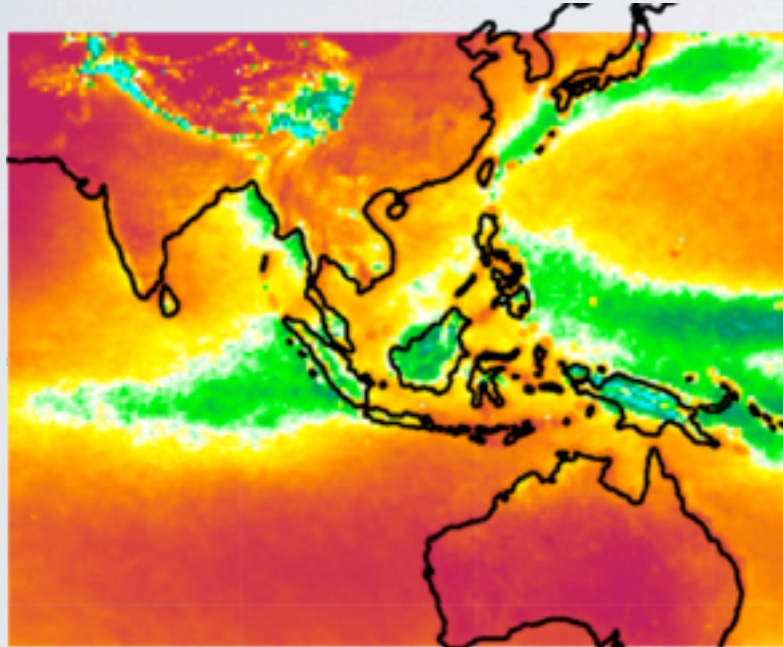
North America Nest (NA)



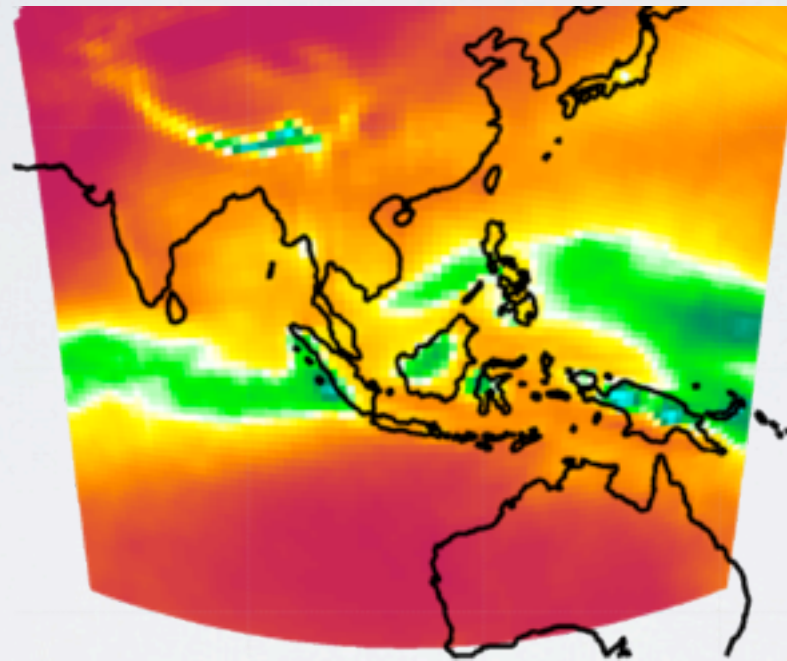
MARITIME CONTINENT ANNUAL PRECIPITATION



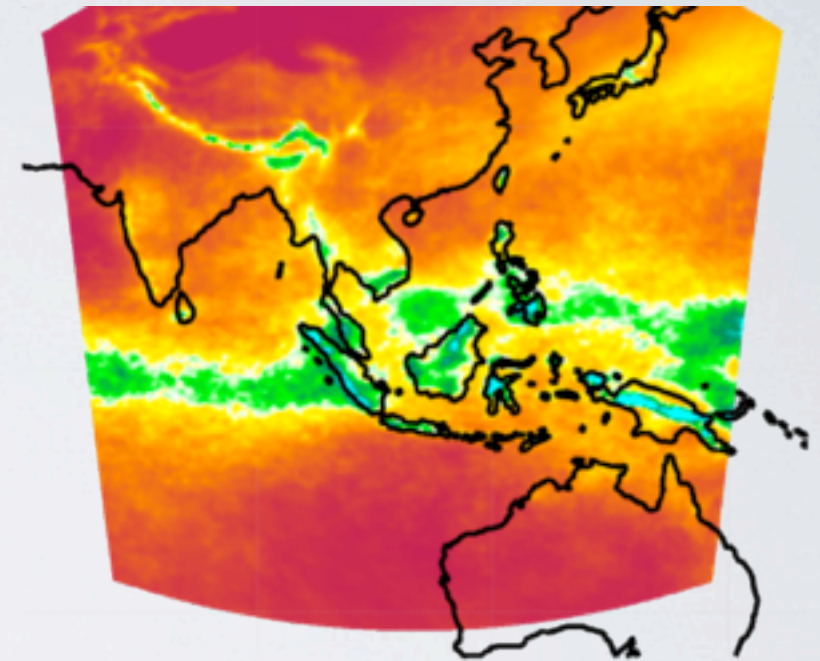
TRMM x 1.3 Annual Precipitation



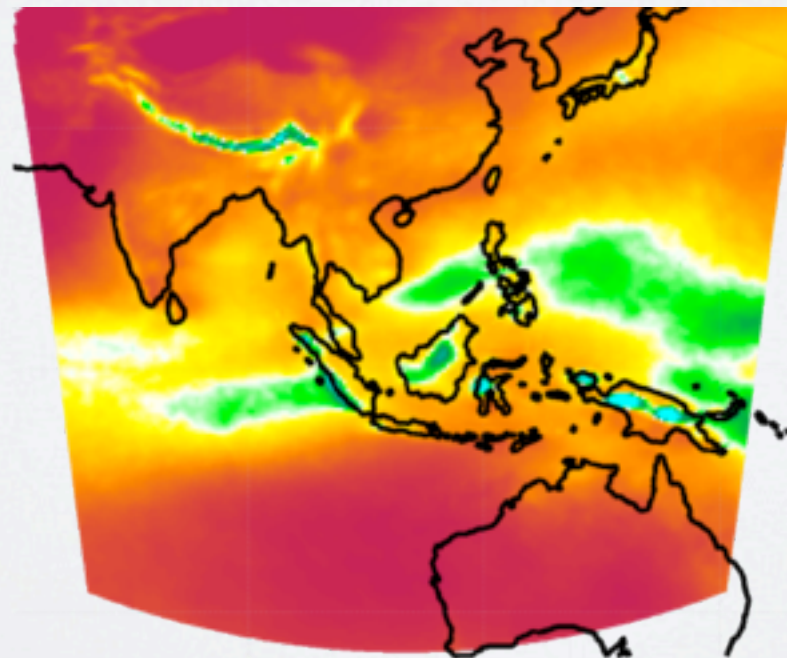
c90 Ig AMIP



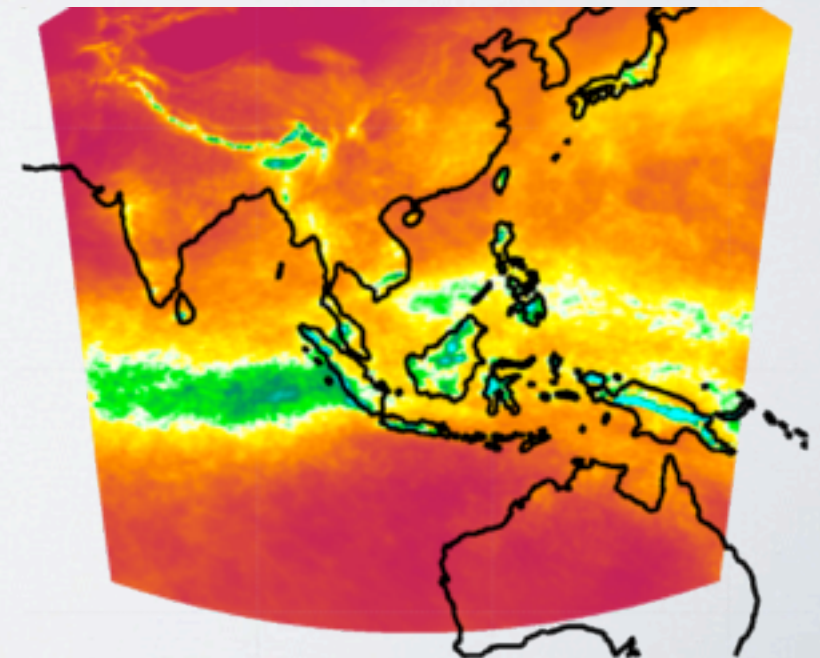
c90 MC Nest Climo SST



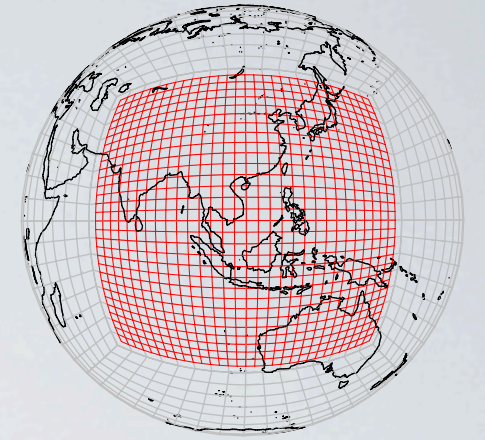
c192 Ig AMIP



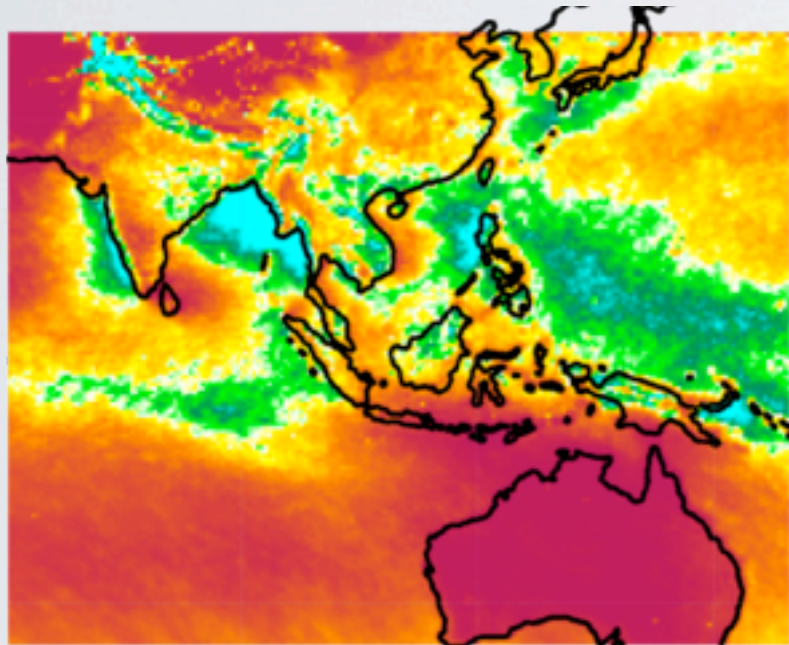
c192 MC Nest Climo SST



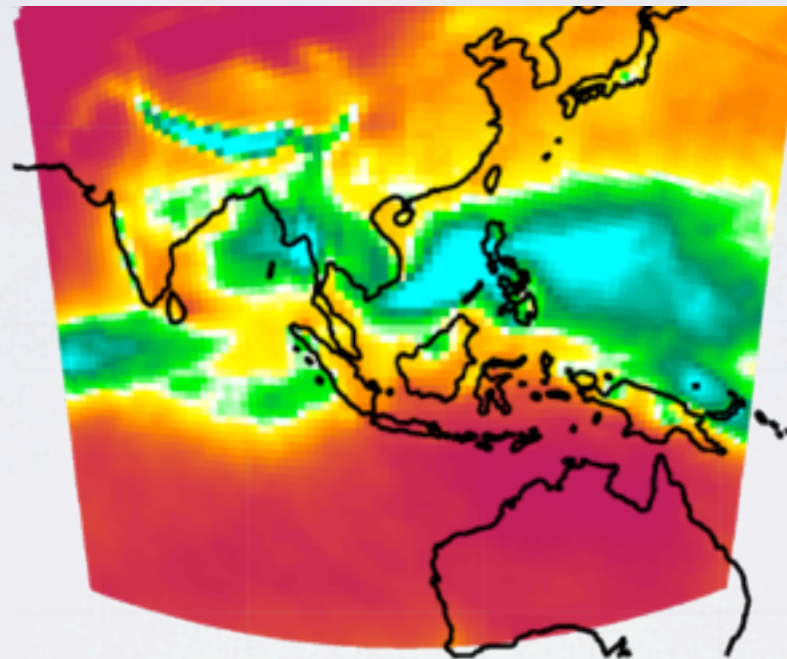
MARITIME CONTINENT MONSOON PRECIPITATION



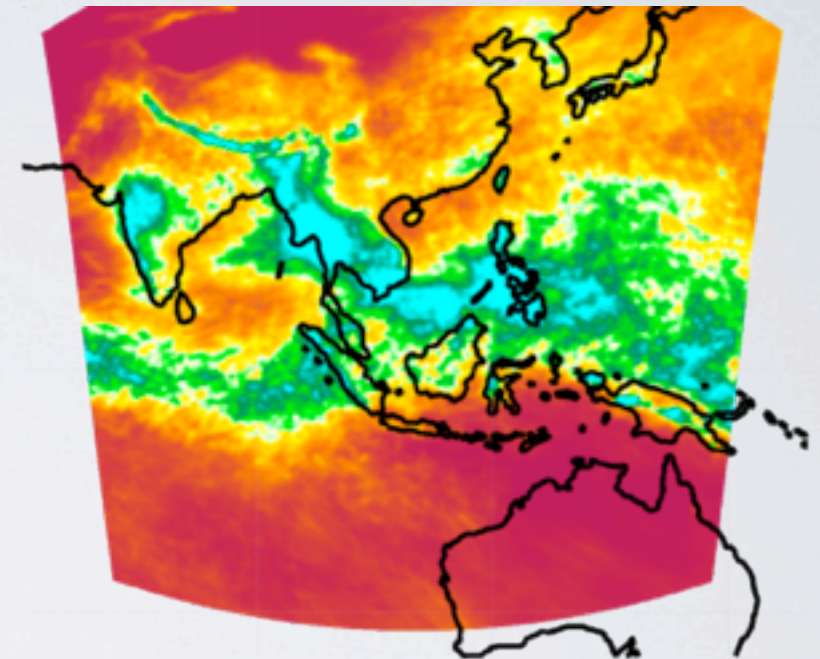
TRMM x 1.3 JJA Precipitation



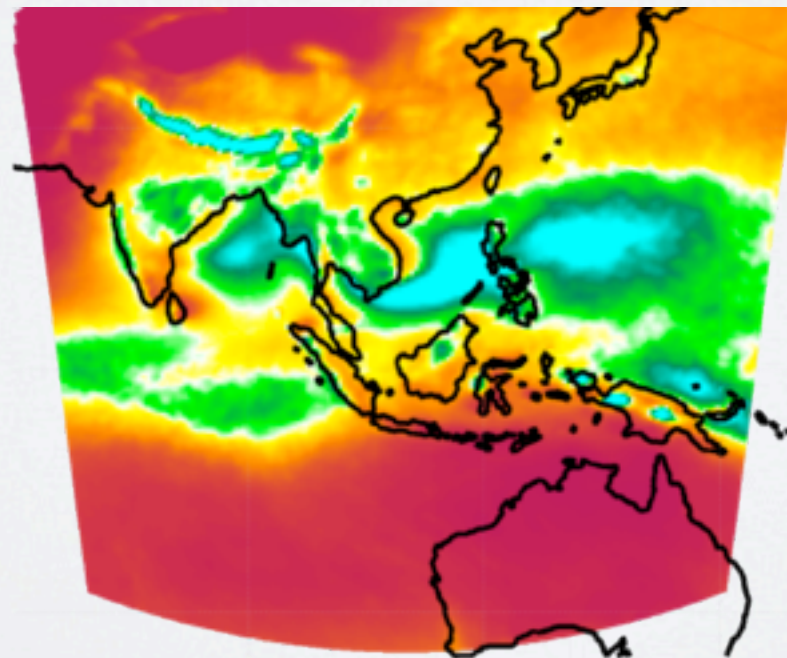
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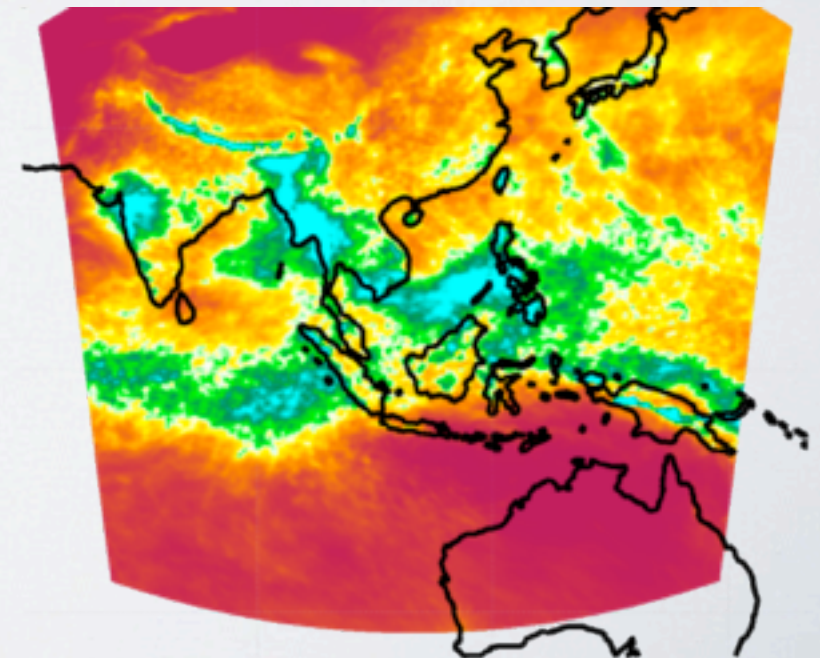
c90 MC Nest Climo SST



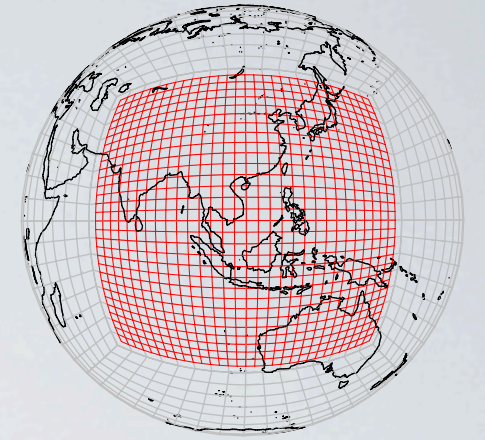
c192 Ig AMIP



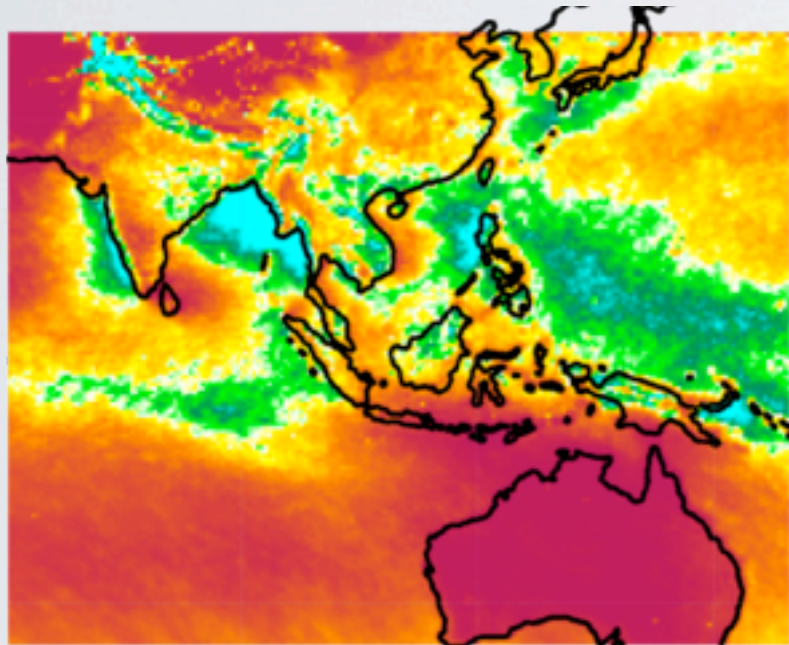
c192 MC Nest Climo SST



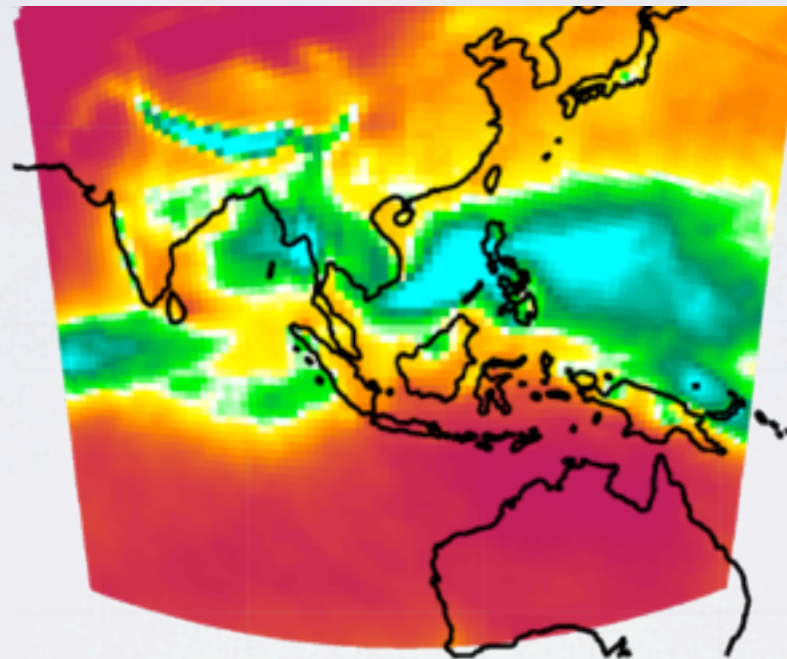
MARITIME CONTINENT EFFECT OF PARAMETERIZATION TUNING



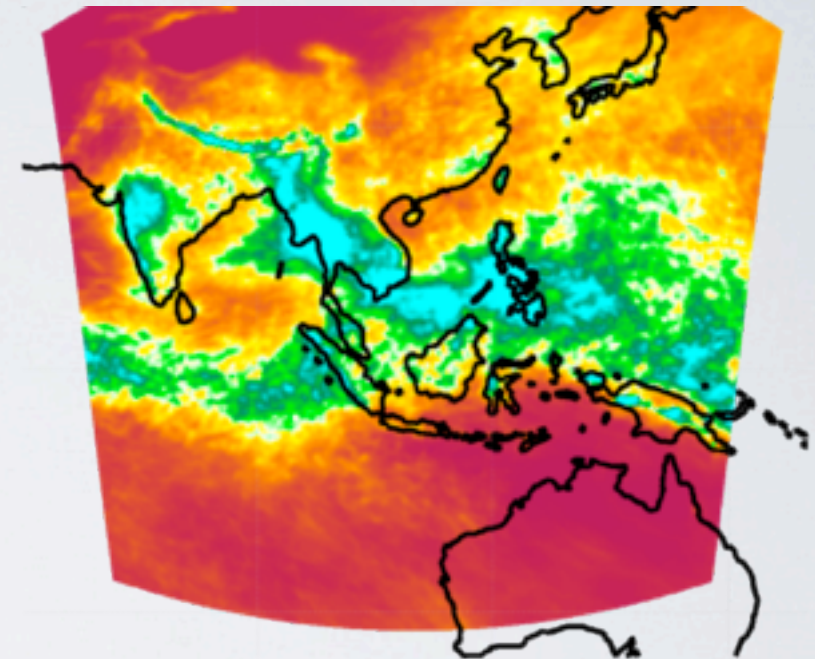
TRMM x 1.3 JJA Precipitation



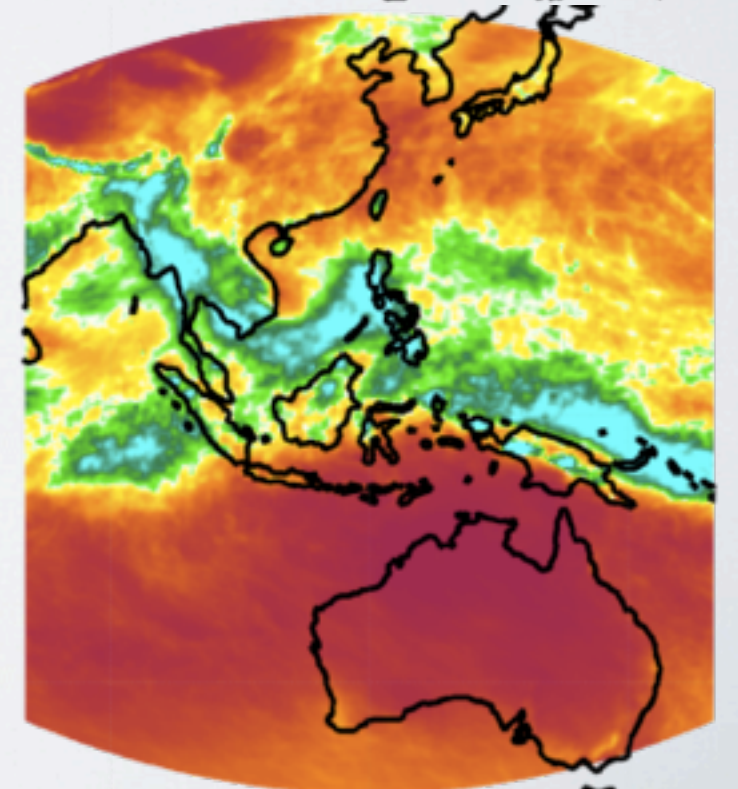
c90 Ig AMIP



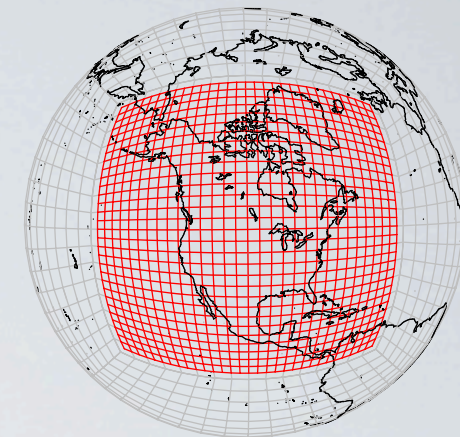
c90 MC Nest Climo SST



c90 MC Nest Climo SST
Nested tunings same as
on coarse grid



US WINTER PRECIPITATION



PRISM DJF Precipitation

c90 Ig AMIP

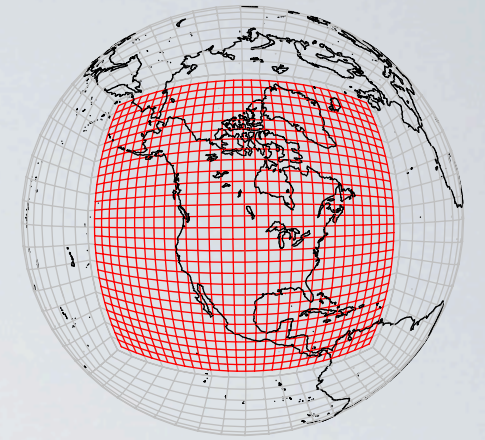
c90 NA Nest AMIP

c192 Ig AMIP

c90 NA Nest Climo SST

mm/d

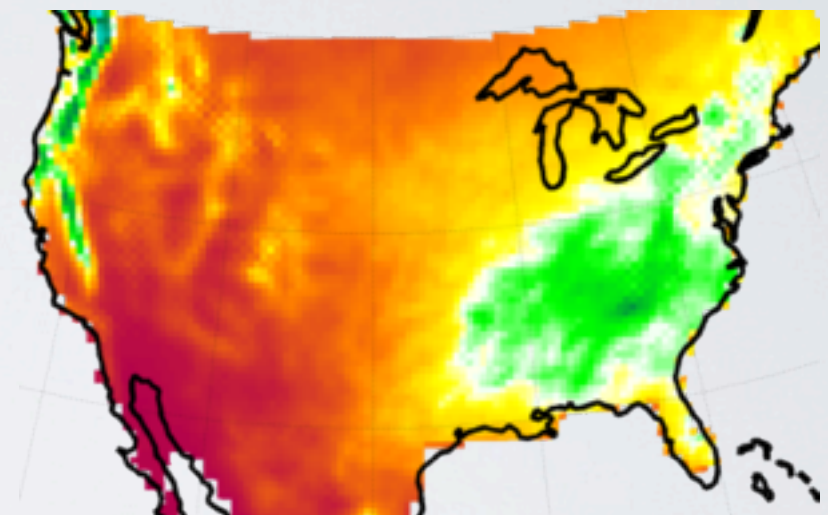
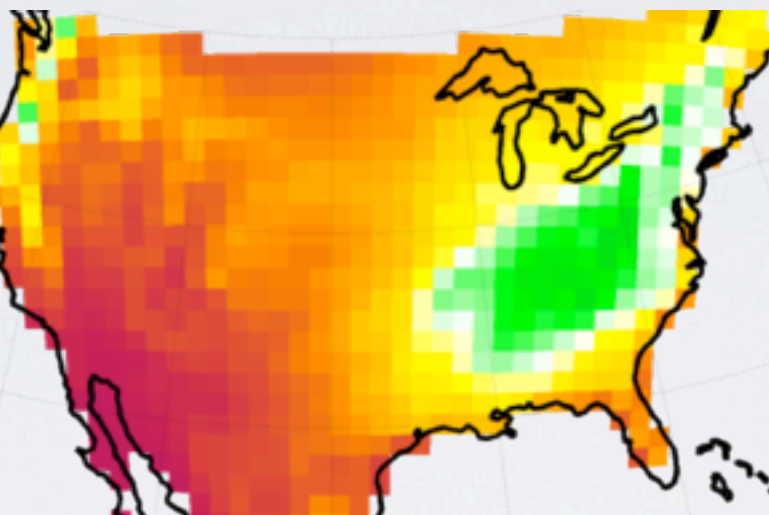
US SPRING PRECIPITATION



PRISM MAM Precipitation

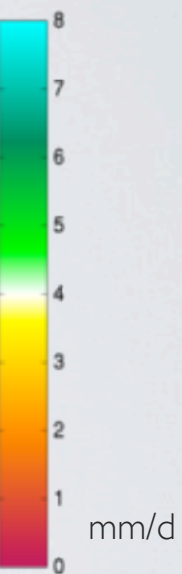
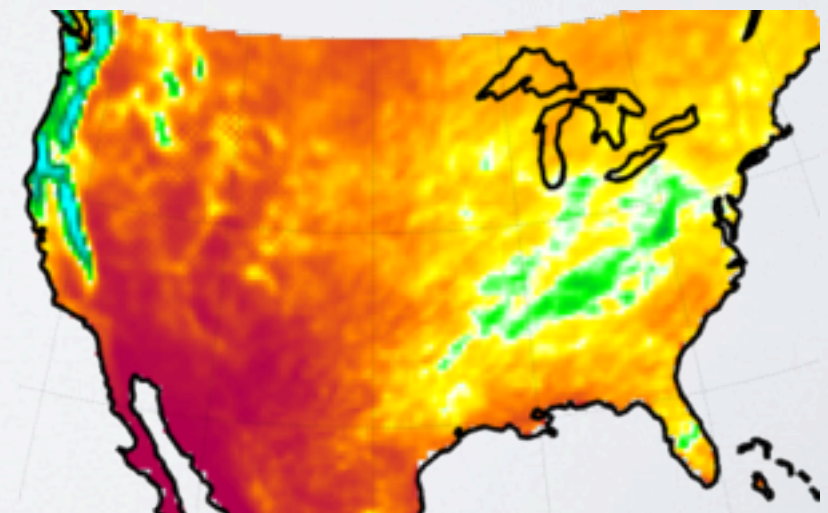
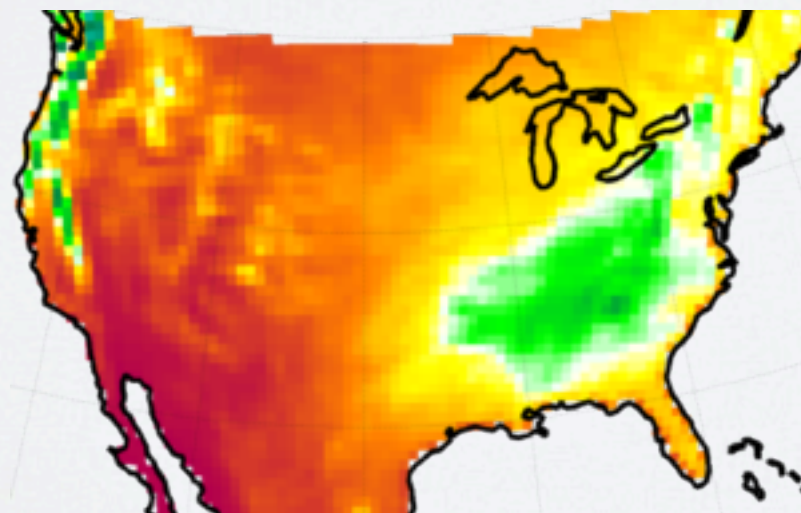
c90 Ig AMIP

c90 NA Nest AMIP

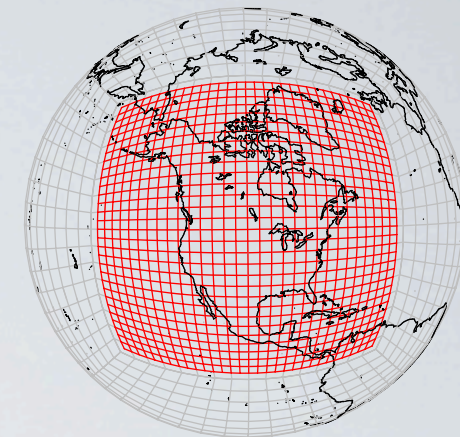


c192 Ig AMIP

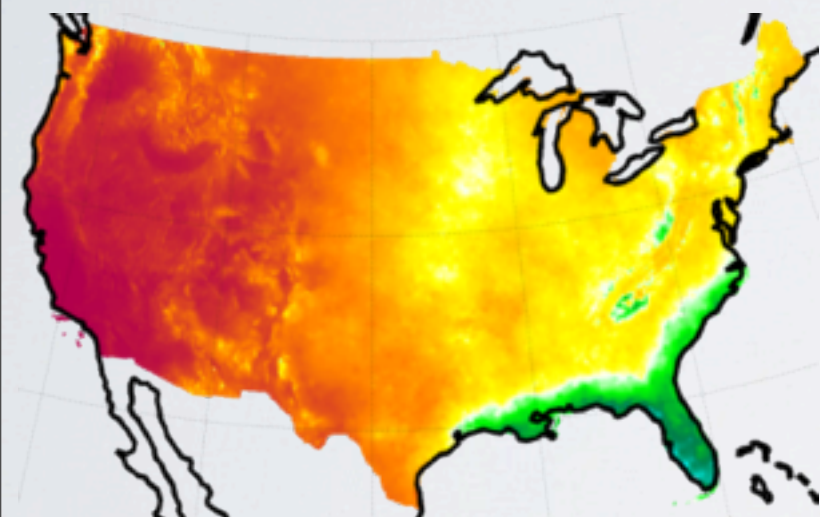
c90 NA Nest Climo SST



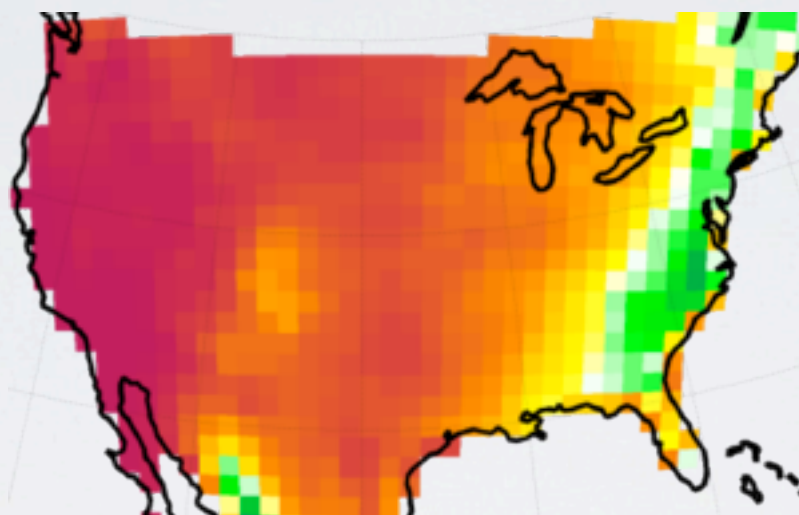
US SUMMER PRECIPITATION



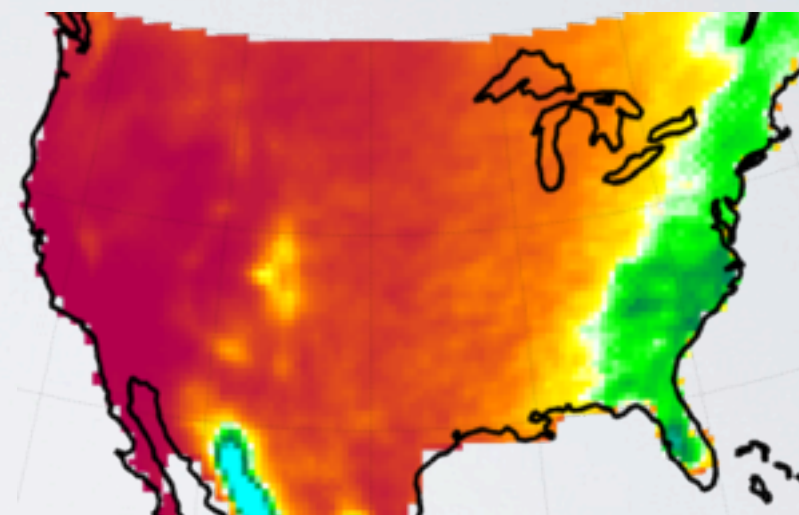
PRISM JJA Precipitation



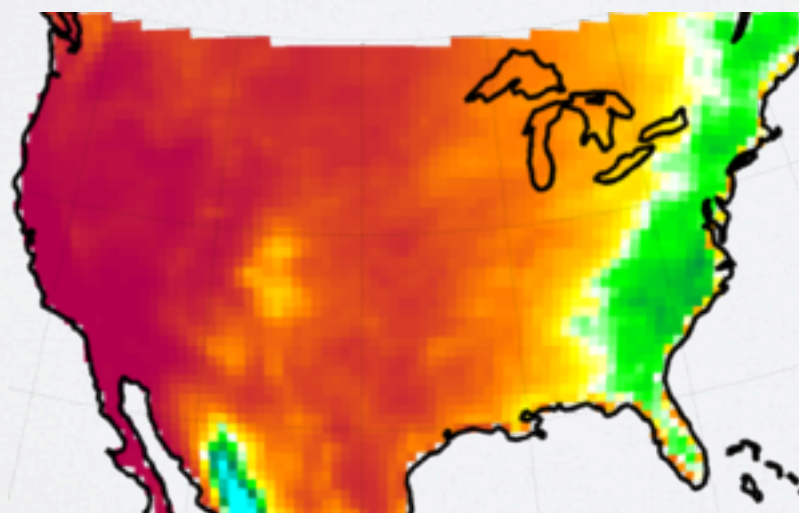
c90 Ig AMIP



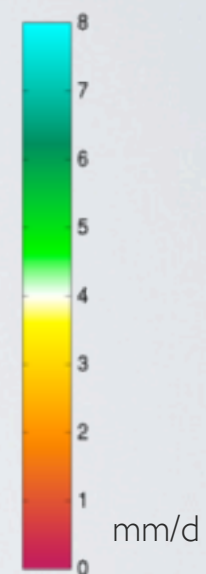
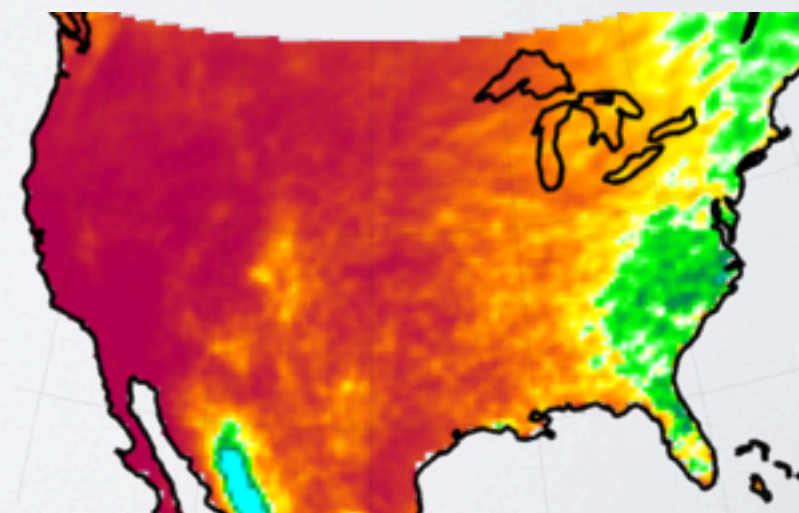
c90 NA Nest AMIP



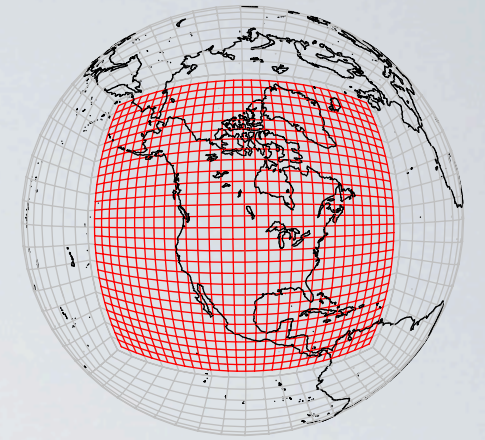
c192 Ig AMIP



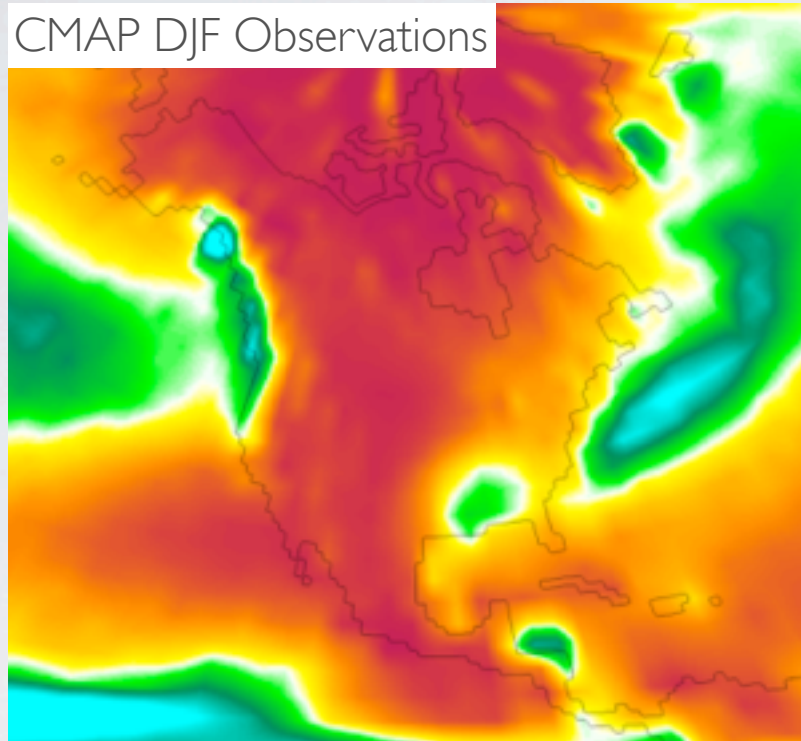
c90 NA Nest Climo SST



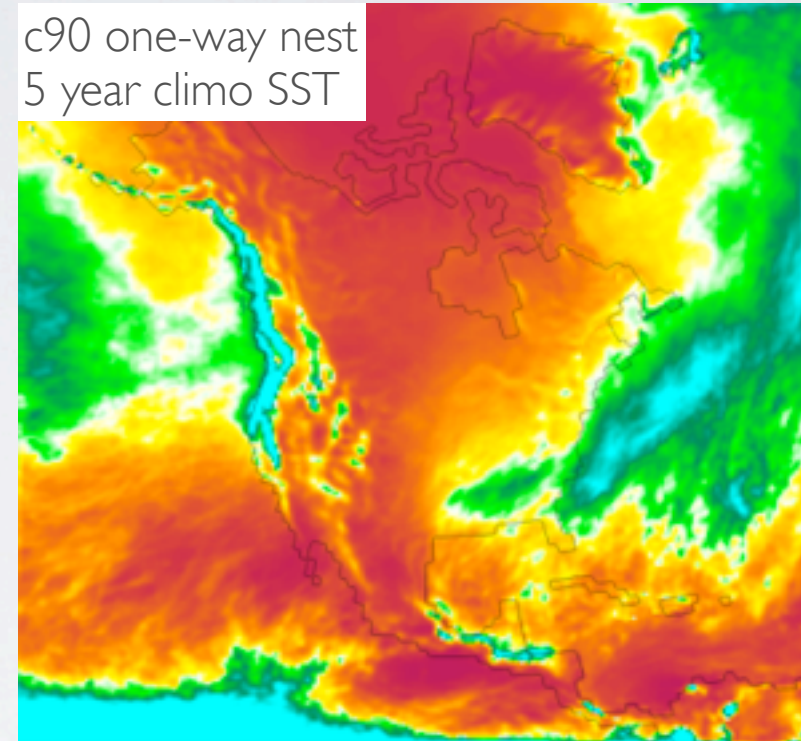
WINTER PRECIPITATION TWO-WAY VS. ONE-WAY NESTING



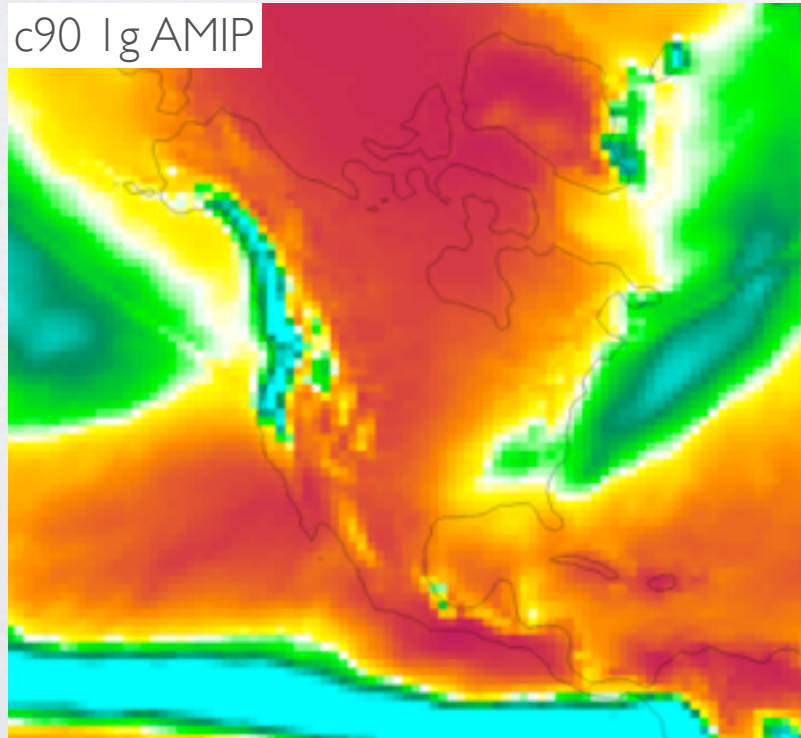
CMAP DJF Observations



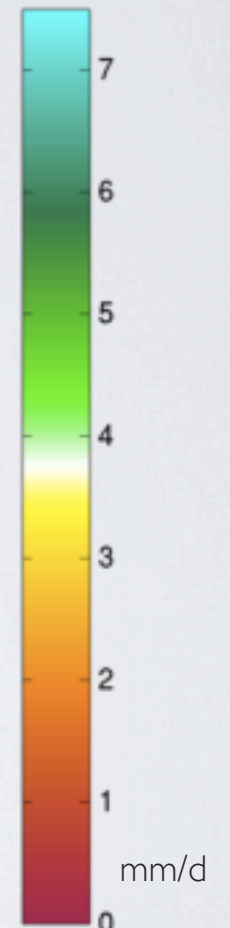
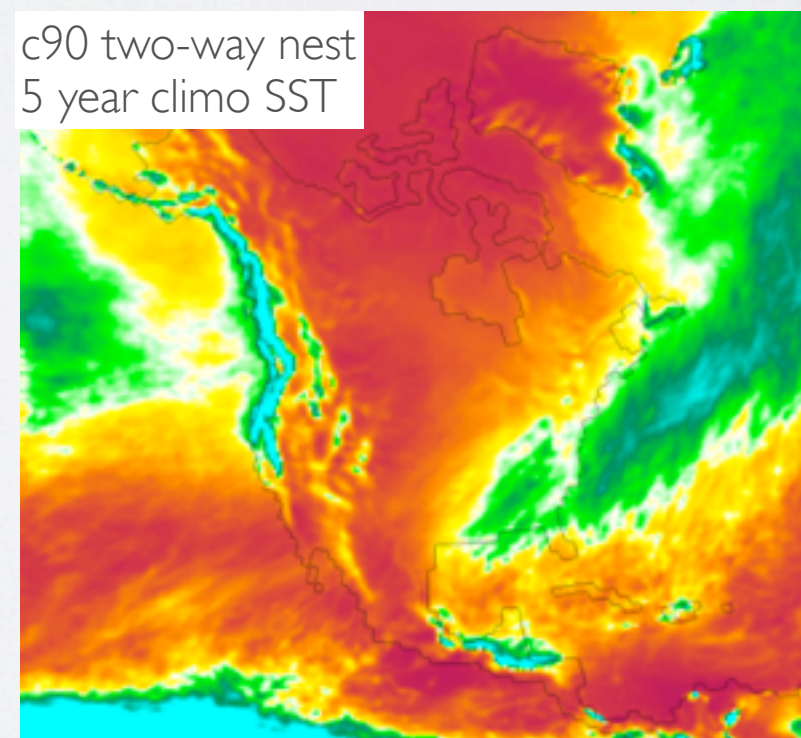
c90 one-way nest
5 year climo SST



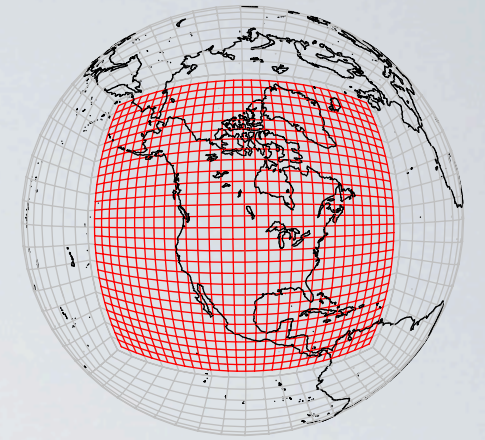
c90 1g AMIP



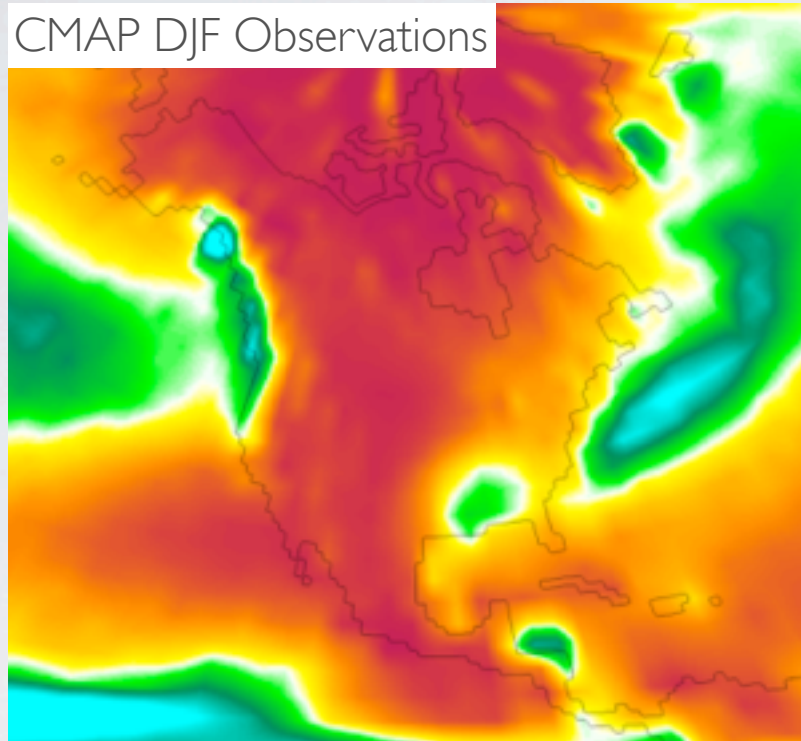
c90 two-way nest
5 year climo SST



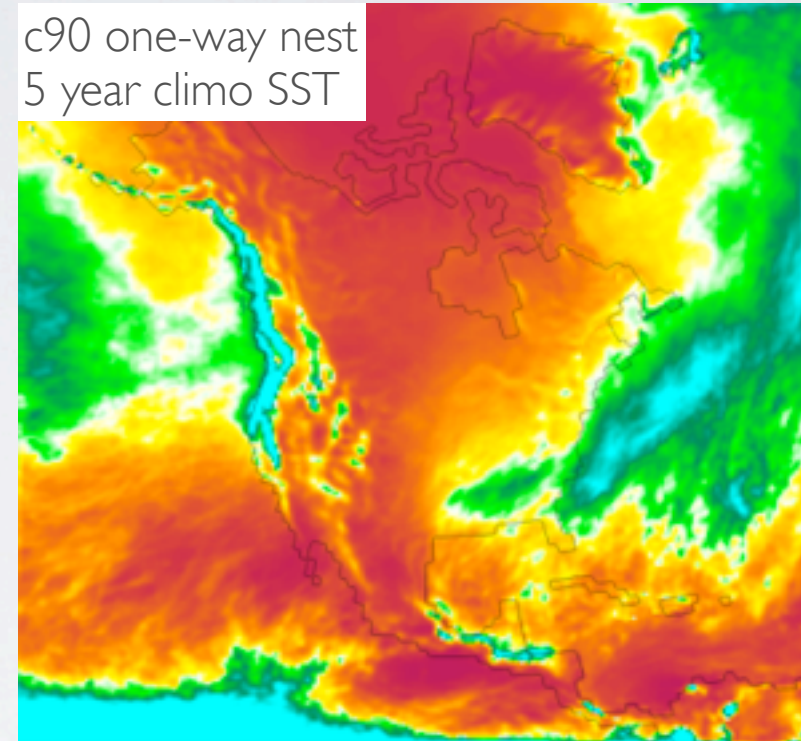
WINTER PRECIPITATION TWO-WAY VS. ONE-WAY NESTING



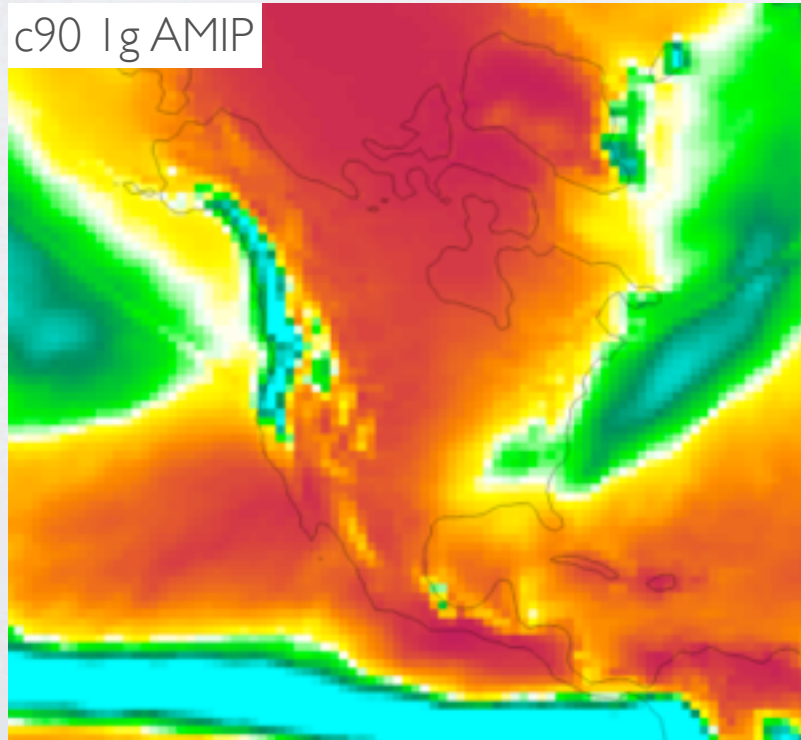
CMAP DJF Observations



c90 one-way nest
5 year climo SST



c90 1g AMIP



c90 two-way nest
AMIP

